A Study of *Schoutedenia lutea* (van der Goot, 1917) (Homoptera: Aphididae)

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ABSTRACT

Observations on a population of the aphid *Schoutedenia lutea* have been made over a period of several years. The annual cycle is described. Sexuales occur concurrently with parthenogenetic females throughout summer and autumn. Some morphological and taxonomic notes are provided on the fundatrix, a green viviparous form, the sexuales and the eggs. *Schoutedenia viridis* is confirmed as a synonym of *S. lutea*. A number of insect parasites, hyperparasites and predators of *S. lutea* have been reared and are listed.

INTRODUCTION

Schoutedenia lutea (van der Goot) is a member of a small group (Schoutedeniini) of eight known genera in the subfamily Greenideinae, which is distributed in South America, Africa, India, Australia and in eastern Asia, northward to Japan, and includes two indigenous Australian genera, *Anomalaphis* Baker and *Meringosiphon* Carver.

S. lutea itself occurs naturally in Australia, S.E. Asia and India and probably Africa and China also, but its true range will not be determinable until the species composition of *Schoutedenia* is elucidated. The following species and subspecies of *Schoutedenia* have been described: *S. ralumensis* Rübsaamen, 1905; *S. lutea* (van der Goot, 1917); *S. viridis* (van der Goot, 1917); *S. bougainvilleae* (Theobald, 1920); *S. formosanus* (Takahashi, 1929); *S. emblica* (Patel and Kulkarni, 1952); *S. emblica andhraka* David and Hille Ris Lambers, 1956. However, some synonymy is suspected (Ghosh *et al.*, 1972; Eastop, 1966; Tao, 1962) and it is likely that the genus actually contains only one or two species.

Schoutedenia has been recorded from woody plants of the family Euphorbiaceae. The only known host plant of *S. lutea* in Australia is *Breynia oblongifolia* J. Muell., a small bush growing to 2 m high in or near rainforest and in sandstone bushland in New South Wales and Queensland, northward to Cape York.

MATERIALS AND METHODS

All collections were made in sandstone bushland in the Sydney suburb of Mosman. Observations were made from 1972 to 1975 inclusive, during spring, summer and autumn. At each inspection, notes were made of the morphs present. Predators and parasites were collected and reared for identification.

For taxonomic studies, microscopic mounts were made according to the method recommended by Stroyan (van Emden, 1972). Dissections were carried out in saline solution and serial sections were prepared from material fixed in alcoholic Bouin's solution containing 0.5% trichloracetic acid and stained with Mayer's haemalum and celestin blue, or with Regaud's iron haematoxylin and phloxin or fast green.

ANNUAL CYCLE

The following account is a composite summary based on three seasons' observations. Table 1 gives a full month-by-month summary of morphs present. Fundatrices hatched in mid-September, although fresh shoots were present on the host plant from the beginning of August. Production of viviparae commenced at the end of September and, by late October, the first males were observed. Thereafter, apterae viviparae, alatae viviparae, oviparae and males were present in the population until May, except in 1974, when no aphids were observed after February. Occasional monthly samples after October lacked males and/or alatae viviparae.

TABLE 1

COLLECTIONS OF *SCHOUTEDENIA LUTEA* (VAN DER GOOT)

		1972/1973	1973/1974	1974/1975
SPRING	Sept.	—	Fundatrices	—
	Oct.	—	apt; ♂♂	nil
	Nov.	apt; al; ♀♀; ♂♂	apt; al; ♀♀	—
SUMMER	Dec.	apt; al; ♀♀; ♂♂	apt; al; ♀♀	—
	Jan.	apt; al; ♀♀; ♂♂	apt; ♀♀; ♂♂	apt; al; ♀♀; ♂♂
	Feb.	apt; ♀♀	apt; ♀♀; ♂♂	apt; al; ♀♀; ♂♂
AUTUMN	Mar.	apt; al; ♀♀	nil	apt; al; ♀♀; ♂♂
	Apr.	apt; al; ♀♀; ♂♂	nil	apt; al; ♀♀; ♂♂
	May	apt; al; ♀♀	nil	apt; al; ♀♀
WINTER	June	—	—	apt; al
	July	—	—	nil
	Aug.	nil	—	nil

apt. = apterae viviparae
al. = alatae viviparae
nil = no live aphids found
♀♀ = oviparae
♂♂ = males
— = no survey

Eggs were laid continuously from November to May but presumably did not hatch until the following spring, as fundatrices were found only in spring.

The aphid was not confined to fresh shoots and could be found on young leaves, older leaves and on stems of *B. oblongifolia.* Although the host plant was common in the area, few individual plants were colonised by *S. lutea.* On colonised plants, however, aphid numbers rose to very high levels; over 80 individuals per leaf were counted, corresponding to a density of about 40 cm^{-2}. In late December or early January, alatae viviparae initiated secondary colonies on neighbouring bushes. These however did not usually reach the size of the primary colonies. Large populations of aphids appeared to damage the plants; the leaves turned yellow and were shed.

MORPHOLOGICAL AND TAXONOMIC NOTES

Egg

When freshly laid, the egg is light orange in colour and has a white papilla at the apex of the posterior (wider) end. Elongated but not flattened and somewhat irregular in cross section, it might best be described as banana-shaped (Fig. 1). Length of 20 eggs of *S. lutea* laid in the laboratory: 0.62-0.73 mm (mean = 0.68); width: 0.18-0.24 mm (mean = 0.21). Field-laid eggs may be a little larger. Within a day or so of being laid the eggs turned black. They were generally laid in leaf axils or in cracks in the bark, and were curved to fit the contours of the substratum. Eggs within macerated oviparae lack the papilla and instead appear truncate or faintly concave in this area. The papilla is presumably lost during maceration. Macerated eggs of *S. bougainvilleae* are similarly truncated at the posterior end (Eastop, 1961).

Fig. 1. Egg of *Schoutedenia lutea* (van der Goot).

TABLE 2

COMPARISON OF MORPHS OF *SCHOUTEDENIA LUTEA* (VAN DER GOOT)

	fundatrix	aptera green	vivipara yellow	ovipara	alata vivipara	male	intermediate males
Mean body length (mm)	1.53	1.49	1.66	1.71	1.60	1.43	1.22
,, antennal length (mm)	0.76	0.81	1.04	1.17	1.19	1.22	0.92
,, ant. sgt. III (mm)	0.40	0.28	0.40	0.46	0.45	0.45	0.29
,, ant. sgt. IV (mm)	—	0.17	0.22	0.25	0.26	0.28	0.22
,, ant. sgt. IV base or Vb (mm)	0.17	0.15	0.19	0.22	0.23	0.23	0.20
,, ant. sgt. IV p.t. or V p.t. (mm)	0.08	0.08	0.10	0.12	0.12	0.12	0.10
antennal length/body length	0.47-0.53	0.49-0.56	0.56-0.69	0.62-0.74	0.72-0.82	0.82-0.88	0.72-0.78
p.t./base	0.45-0.48	0.42-0.59	0.44-0.63*	0.52-0.61	0.45-0.61	0.50-0.60	0.49-0.59
ant. sgt. III/p.t.	5.00-5.10	3.02-4.12	3.15-4.75*	3.47-4.00	3.50-4.20	3.33-4.00	2.70-2.90
ant. sgt. III/IV + V	—	0.66-0.77	0.65-0.86*	0.76-0.82	0.69-0.76	0.68-0.80	0.55-0.58
u.r.s./h.t.2	←		0.60-0.77				→
length spinal processi/body length	0.16-0.18	0.15-0.17†	0.14-0.18	0.14-0.17	0.09-0.12	0.08-0.10	0.12
hind tibia/body length	0.23-0.24	0.24-0.25†	0.27-0.31	0.28-0.31	0.36-0.40	0.36-0.41	0.34-0.37
No. of specimens studied	3	9	7	6	8	8	2
Month of collection	ix	ii	ii, iii, iv	ii, iii, iv	ii, iii, iv	ii, iii, iv	iv

p.t. = processus terminalis u.r.s. = ultimate rostral segment h.t.2 = second hind tarsal segment

*Includes values obtained from measurements of 15 yellow apterae viviparae collected concurrently with green apterae viviparae tabled in previous column

†Values from three specimens only

Oviposition was observed but had no unusual features. The ovipara stretched the abdomen posteriorly at the commencement of laying and gradually drew the tip forwards as the egg was extruded. The ovipara then moved away without giving further attention to the egg.

Fundatrix

Readily identifiable in field; deeper yellow than other apterae viviparae and with patches of brown on head and dorsum of thorax and abdomen. Antennae shorter than those of other morphs and only 4-segmented, segment III being proportionately longer than in other morphs; without secondary rhinaria; flagellar hairs about 9 μm in length, short, blunt, pale, sparse, i.e. usually no more than one hair near each rhinarium (in addition to apical hairs). Body pale; dorsal body hairs 5-8 μm long; a little shorter and sparser than in other apterae viviparae; siphuncular hairs 5-13 μm long; hairs on spinal processi 13 μm long; tergite VII with two pleural hairs, lateral to spinal processi; tergite VIII with two hairs, 7-19 μm long. Legs proportionately shorter than those of other morphs. Subanal plate apical, small, pale, spinosely imbricated, with 8-12 short and fine to long and stout hairs, symmetrically arranged. Subgenital plate pale, spinosely imbricated, with 4 anteriorly placed hairs and 5-8 posterior hairs. Gonapophyses consist of 4 groups each of 2-4 minute hairs. For further comparison with other morphs, see Table 2.

Aptera vivipara

Apterae viviparae of *S. lutea* are usually a clear, uniform lemon-yellow in colour. Green viviparous specimens were found from time to time intermingled with yellow ones; on closer inspection, the green specimens proved to be alatoid individuals with varying degrees of development of wings, thorax, ocelli and compound eyes. Yellow alatoid apterae also occurred and once (2.ii.75), a collection was made which contained only green apterae viviparae (and darker, olive-green oviparae). These specimens possessed no alatoid characteristics and gave birth in the laboratory to the usual yellow apterae. The field colony contained only yellow specimens when next checked (20.iii.75). A comparison of these green *Schoutedenia* with yellow apterae viviparae collected on the same day from a locality a few kilometres distant showed no significant differences except perhaps one of size (see Table 2).

Oviparous female

Apterous. Living specimens olive-green in colour, in contrast to the lemon-yellow or lighter green colour of the apterae viviparae; orange coloured eggs often visible through the body wall. Antennae 5-segmented, without secondary rhinaria; flagellar hairs as in aptera vivipara, 8-12 μm long; segment III with only 5 hairs, segment IV with only 2, near rhinarium; segment V with only 1, near rhinarium (in addition to apical hairs). Legs with 9-20 pseudosensoria on the hind *femur;*

these are difficult to distinguish from the pronounced gland-like ornamentation of the femora. Body hairs as in aptera vivipara, sparse; on anterior abdominal tergites, with a maximum of 2 spinal hairs, 8-9 μm long, and 2 submarginal hairs on each side; tergite VII with 2 pleural hairs lateral to spinal processi; hairs on spinal processi approximately 13 μm long; tergite VIII with 2 hairs, 16-43 μm long. Posterior abdominal segments somewhat attenuated. Subanal plate apical, large, pale, spinosely imbricated, with 80-90 hairs varying in size from small and fine to long and stout (cf. that of vivipara with only 10-12 hairs): subgenital plate large but not obviously demarcated; presence indicated by 2 transverse groups of variously sized, fine, pale hairs; each group with 30-40 hairs (cf. that of aptera vivipara, with 2 rows each of usually 6 hairs). Gonapophyses borne on 3 pronounced tubercles, the outer tubercles, 42-64 μm long, both inclined posterolaterally and each with 4-6 hairs; inner tubercle shorter, 35-50 μm long, sometimes appearing faintly bifid at apex; with 6-8 hairs (cf. viviparae whose gonopophyses consist of 4 groups each of 2-5 hairs, which are very rarely borne on 3 very small, flat, pale tubercles). For further comparison with other morphs, see Table 2.

An internal structure, which persists after maceration, is very conspicuous in the abdomen of some oviparae. This structure consists of two large, broad, irregularly shaped, greenish arms which are united posteriorly by a narrow isthmus. It is also present in oviparoid nymphs, but the arms are not united. Dissection and serial sections showed that the structure corresponded to the accessory glands of the reproductive system. The sections also showed that the accessory glands contain a refractile green substance which is not removed by ordinary histological solvents. The precise nature and function of this substance are not known but presumably it forms a protective or adhesive layer on the surface of the eggs as they are deposited. Dissection of several oviparae showed four ovarioles on each side of the body cavity. Each ovariole contained one or

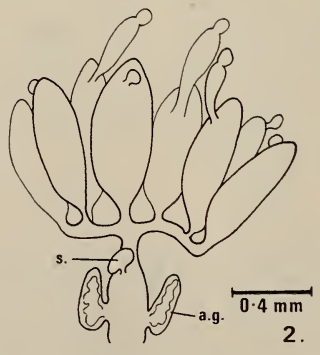

Fig. 2. Reproductive system of *S. lutea* (ovipara). Abbreviations: s.—spermatheca; a.g.—accessory gland.

two large eggs. A diagrammatic representation of the reproductive system is given in Figure 2.

The presence of pseudosensoria on the hind femora is very unusual, the only other published instances being *S. bougainvilleae* and the related *Eonaphis euphorbiae* (Eastop, 1961; Quednau, 1964). These observations conflict with the references to the occurrence of pseudosensoria on the tibiae of oviparae of *S. lutea* and *S. emblica andhraka* (Ghosh *et al.*, 1972; David and Hille Ris Lambers, 1956).

Male

Alate. Antennae proportionately longer than those of other morphs; 5-segmented, with 47-59 circular secondary rhinaria on antennal segment III, 13-24 on segment IV and 0-2, usually 0, on segment V (compared with 27-37 secondary rhinaria on segment III and 0-7 on segment IV in alata vivipara); concentrated on ventral surface. Tibiae and spinal processi spinosely imbricated, as in alata vivipara. Genitalia comparatively simple, not heavily sclerotized; claspers roughly trapezoidal in shape and medially acutely triangular; armature not extensive; penis short, sparsely haired; about 19 hairs at base of genitalia, which are anterior to or are a continuation of subanal plate. For further comparison with other morphs, see Table 2.

On at least two occasions (30.iv.73, 8.i.75), a few small, apparently functional males were collected, possessing varying combinations of apteroid and alatoid characteristics. The genitalia appeared to be normal, and compound eyes and ocelli were present but the specimens possessed abortive wings, a variously developed thorax and a varying and intermediate number of secondary rhinaria on the oddly proportioned antennal segments. In addition, they were noticeably smaller than specimens of any other morph studied.

Ghosh *et al.* (1972) have briefly described the male of *S. lutea* and David and Hille Ris Lambers (1956) the apteroid male of *S. emblica andhraka.*

The males, alatae viviparae and alatiform nymphs were green in colour.

PREDATORS AND PARASITES

The populations of *S. lutea* were subject to attack by a range of other insects. Where possible, the predators, parasites and hyperparasites were reared and identified.

A. *Predators*

1. Diptera: Syrphidae. Larvae of *Simosyrphus grandicornis* (Macquart) and a second species, probably *Melangyna viridiceps* (Macquart). Predation by larvae of these species was heavy, particularly in spring. *Diplazon laetatorius* (F.) (Hymenoptera: Ichneumonidae) was reared from *S. grandicornis.*

2. Diptera: Chamaemyiidae. *Leucopis* sp. (probably undescribed). This species was very common, the larvae consuming large numbers of *S. lutea* throughout the summer. Their passage through a colony was marked by the presence of dead, brown aphids hanging by their stylets.

   Two specimens of *Euryischia* sp. (Encyrtidae: Eriaporinae) were reared from two puparia of this predator. Species of this genus are hyperparasites through parasitic Diptera (Riek, pers. comm.).

3. Coleoptera: Coccinellidae. *Coelophora inaequalis* (F.), *Amidellus ementitor* (Blackburn), *Leis conformis* (Boisduval). Adults and larvae of these were observed from time to time. They did not appear to affect well-established colonies greatly. On one occasion, *L. conformis* was found to be parasitised by dipterous larvae, *Phalacrotophora* sp. (Phoridae: Metopinae) probably undescribed. Four parasite larvae emerged from the remains of the host pupa, and pupated separately, alongside their host.
4. Neuroptera: Hemerobiidae. *Micromus tasmaniae* Walker. Not common. Surprisingly, no Chrysopidae were observed.

B. *Parasites*

1. Hymenoptera: Chalcidoidea: Aphelininae. *Aphelinus gossypii* Timberlake. *Aphelinus gossypii* is at times a common parasite, in N.S.W. and South Australia at least, of many species of Aphidinae. While parasitism of *S. lutea* by this species sometimes reached moderate levels (the brownish gut contents of the parasite larva could be seen through the body wall of the living host), few mummified aphids and adult *Aphelinus* were obtained.

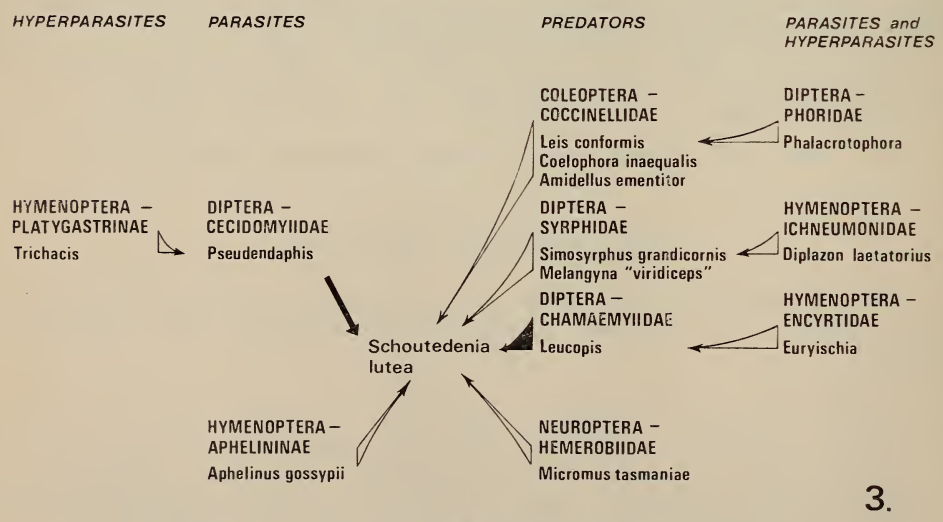

Fig. 3. Parasites and predators of *Schoutedenia lutea*.

2. Diptera: Cecidomyiidae. *Pseudendaphis* sp. This may be an undescribed species but its status will be uncertain until there has been a thorough revision of cecidomyiid endoparasites of aphids (Harris, pers. comm.). The species was extremely common from January to May as an endoparasite of *S. lutea*. The cecidomyiid larvae were in turn parasitised by a minute wasp, *Trichacis* sp. (Proctotrupoidea: Platygastrinae). Members of the Platygastrinae are usually parasites of gall-forming Cecidomyiidae. Cecidomyiids have not previously been recorded as aphid parasites in Australia.

C. *Relationships with ants*

At least four species of ants were observed from time to time collecting honeydew from colonies of *S. lutea*.

The relationships of *S. lutea* with other insects are shown diagrammatically in Fig. 3. With the exception of *Pseudendaphis* sp. specimens of those insects not identified to species have been deposited in the Australian National Insect Collection, C.S.I.R.O., Canberra, A.C.T.

DISCUSSION

The annual cycle of *Schoutedenia lutea* in the Sydney region can be summarised as follows: fundatrices hatch in early spring (mid-September) and produce a generation of apterous fundatrigeniae. Adult males were first noted in late October, and oviparae in mid-November. It is therefore probable that the third generation can include males, and the following generation oviparae. After this time, alate and apterous viviparae as well as sexuales occur concurrently until the onset of the following winter. There is no evidence in the literature to indicate whether or not the life cycle of *S. lutea* has similar unusual features in other parts of its geographical range.

Other species producing sexuales early in the season either as the final morphs of an abbreviated life cycle or concurrently with viviparae include some Japanese species of *Greenidea, Paratrichosiphum* and *Eutrichosiphum* (Takahashi and Sorin, 1959; Takahashi, 1962), some species of the unrelated *Neophyllaphis* in Australia, New Zealand and Japan (see Hales, 1976), and *Sensoriaphis furcifera* in Australia (Carver and Hales, 1974).

Eastop (1961) describes the apterae of *S. bougainvilleae as* "yellow or green" and according to Hille Ris Lambers (pers. comm.), *Schoutedenia* collected in Java were "repeatedly yellow apterae, sometimes yellow apterae with green alatae".

The present study has established that *S. lutea* occurs in two distinct colour forms, yellow and green. Ghosh *et al.* (1972) are of the opinion that *S. lutea, S. viridis* and also *S. bougainvilleae* are synonymous. Tao (1962) lists *S. bougainvilleae* and *S. formosanus* as synonyms of *S. viridis* and Eastop (1966) says that *S. bougainvilleae* may be a synonym of *S. viridis*. Van der Goot (1917) described

(as *Setaphis*) the apterous and alate morphs of two species of *Schoutedenia* viz. *S. lutea,* a yellow aphid, and *S. viridis,* a green aphid, which were additionally distinguishable from one another, in both morphs, by a longer third antennal segment in *S. lutea* relative to the processus terminalis (4:1 in *S. lutea,* 3:1 in *S. viridis*).

It can be seen from Table 2 that this distinction does not hold for our specimens and further comparison of our colour forms and apterous and alate morphs with van der Goot's two descriptions leads to the conclusion that *S. lutea* and *S. viridis* are synonymous.

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